Rapid Ecological Assessment of Forests and Associated Exotic Earthworms in the Laurentian Mixed Forest-Great Lakes Coastal Biological Network, Midwest Region, National Wildlife Refuge System, US Fish & Wildlife Service[1]

FOREST COMMUNITY ANALYSIS: Tamarac NWR

Differences in Overstory Composition Among Stands. Using relative basal area (%) by species of the 85 plots sampled across 15 stands at Tamarac NWR as part of the Rapid Ecological Assessment (Corace et al. 2011), we used a Multi-Response Permutation Procedure (MRPP) to examine if there are differences in the *overall overstory composition* among the 15 stands. MRPP is a non-parametric technique that tests the hypothesis that there is no difference between groups of entities, in this case the overstory composition of stands at Tamarac NWR.

We conducted a MRPP using Sorenson's distance and PC-ORD (ver. 5.0) software. Prior to analysis, we transformed the data using an square root arc sin transformation as is appropriate with percentage data.

Overall, there is a statistically significant difference in the overstory composition among the stands ($T = -21.523$; $A = 0.377$; $P < 0.001$). The results of the MRPP support the data as described in the SUMMARY TABLES & FIGURES document for the Tamarac NWR that suggest differences in the overstory composition (Corace et al 2011). We also calculated post-hoc pairwise comparisons between stands and found statistically significant ($P < 0.05$) differences except for the following stands: AUTO and H35; H35 and WILDE; LITT and OGEM; and SETT and SRIV. In these instances, the *overall* overstory species composition as expressed by relative basal area is similar.

Indicator Analyses. In order to predict if there are significant overstory indicator species for each stand at Tamarac NWR, we used Indicator Species Analysis following the procedure outlined in Dufrene and Legendre (1997). We used PC-ORD (ver. 5.0) to conduct the Indicator Species Analysis using the transformed relative basal area of all species as with the MRPP analysis.

Based upon the Indicator Species Analysis, we found the following species were significant indicators ($P < 0.05$) of the following stands:

Stand	Species	Stand	Species	Stand	Species
AUTO	bigtooth aspen	**H35**	none	**SRIV**	jack pine
BEAV	Am. basswood	**LITT**	black ash	**STAM**	sugar maple
BRUCE	n. red oak	**OGEM**	balsam fir; Am elm	**TEA**	trem. aspen
CHIP	unknown ash	**PARCEL**	paper birch	**WAUB**	bur oak
H135	none	**SETT**	none	**WILDE**	red pine

[1] Authors: Goebel, P.C. (School of Environment & Natural Resources, The Ohio State University, 1680 Madison Ave., Wooster, OH 44691. goebel.11@osu.edu) and R.G. Corace, III (Seney National Wildlife Refuge, 1674 Refuge Entrance Rd., Seney, MI 49883. Greg_Corace@fws.gov). Date published: January 23, 2012.

Gradient Analysis. Using relative basal area by species (%) of the 85 plots sampled across the 15 different stands at Tamarac NWR as part of the Rapid Ecological Assessment (Corace et al. 2011), we examined the distribution of overstory species across sampled stands using Non-Metric Dimensional Scaling (NMDS). NMDS is a non-parametric ordination analysis that maximizes the rank-order correlation between distances. Unlike other indirect (e.g., principal components analysis) or direct (e.g., canonical correspondence analysis) ordination techniques, NMDS does not make any assumptions about the nature of the data, including assumptions about the linear relationship among variables. As a result, it is often viewed as an appropriate multivariate analysis for ecological data (McCune and Grace 2002).

Prior to the analysis, the relative basal area data by species were transformed using an arcsin squareroot transformation as is appropriate with percentage data. NMDS was then run using PC-ORD (ver. 5.0) software using a Sorenson distance measure. A three-dimensional solution was determined to be the most appropriate (Monte Carlo test, *n* = 200 runs).

The results of the NMDS ordination support the results outlined in the previous sections that there are distinct forest communities at Tamarac NWR. However, the NMDS also suggests that there is within-stand heterogeneity in overstory relative basal area as indicated by the overlap of plots representing the different stands in the NMDS ordination (Figure 1). This is especially true for the OGEM, H35, LITT, and H135 stands.

Examining the ordination in more depth, there appear to be several forest community types at Tamarac NWR. These include:

1) Conifer-dominated forest types dominated by red pine and jack pine (SRIV, WILDE, TEA, H135). Fire-intolerant hardwoods are also common, including red maple and trembling aspen. Based upon analyses at Seney NWR, this suggests that these stands may have experienced a long period of fire exclusion.

2) Dry-mesic hardwood forest types dominated by northern red oak, bur oak, black cherry, and bigtooth aspen (AUTO, BRUCE, WAUB, and PARCEL). Based upon known relationships of forest communities across the Great Lakes region, these forest types most likely are found on outwash landforms at Tamarac NWR.

3) Mesic hardwood forest types dominated by sugar maple, American basswood, and green ash (CHIP, BEAV, STAM, and SETT). These forest types are most likely characterized by finer-textured soils associated with glacial moraine landforms.

4) Wet-mesic forest types dominated by black ash and balsam fir (OGEM). These forest types are most likely associated with wetland soils at Tamarac NWR.

While in some instances a single forest community types characterizes an individual stand (e.g., TEA stand dominated by trembling aspen, WAUB dominated by bur oak and northern red oak), there are several stands that have more variable physiographic features that result in multiple forest community types being represented in individual stands. For example, it is likely that the higher areas with better drained soils in the CHIP stand are dominated by American basswood, sugar maple, green ash while

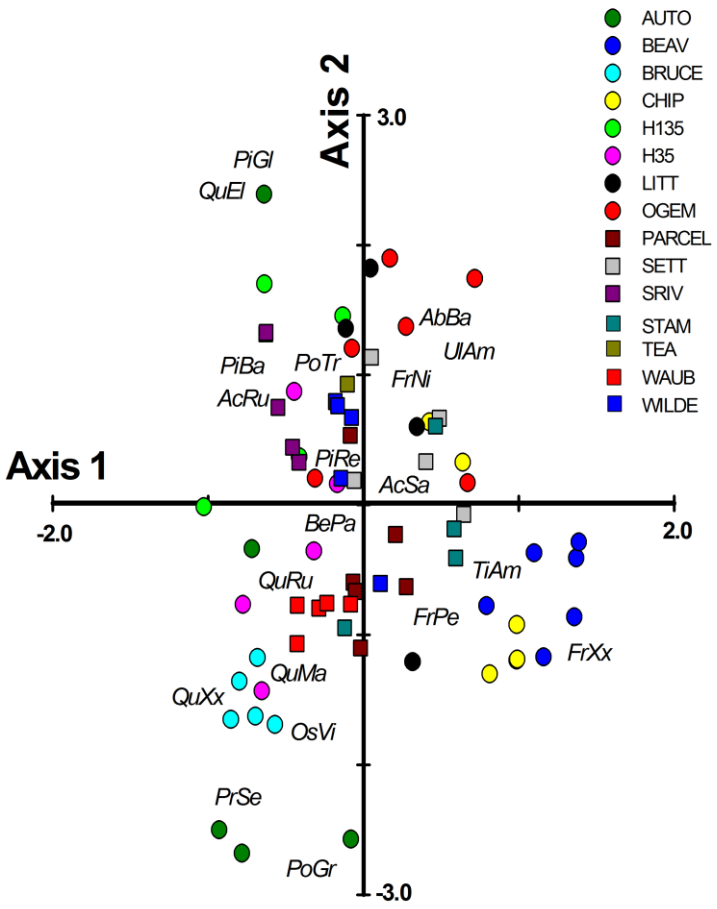

Fig. 1. NMDS ordination of overstory species based upon relative basal area for 15 stands at Tamarac National Wildlife Refuge. Species acronyms correspond to first two letter of genus and species (e.g., QuRu = *Quercus rubra*).

lower and more poorly drained areas in this stand are characterized by black ash and American elm (Fig. 1). Similarly, some areas of the H35 stand are dominated by pine species and other areas are more oak dominated (Fig 1). This may reflect a disturbance gradient or a soil moisture gradient grading from a pine-dominated forest to a more open bur oak-dominated savanna.

These differences indicate there are environmental gradients within individual stands at Tamarac NWR that result in different overstory communities. More information (e.g., soils, past history) on these different stands and plots is needed to make a more conclusive statement regarding the factors driving patterns in overstory composition.

Analysis Implications. These basic results confirm the summary information developed by Corace et al. (2011). Specifically, there are unique forest communities at Tamarac NWR that are dominated by a mixture of species that most likely reflect dominant environmental (i.e., glacial history) and disturbance gradients of the region. While there appear to be four major forest community types, the analyses also strongly indicate that there is considerable variability at local scales within some stands. These results suggest that individual stands may include different overstory communities in response to varying environmental or disturbance related factors within each stand, and as a result may need to be considered separate stands for management purposes (in forest management we typically define a stand as an area that is relatively uniform in terms of species composition and age). While overall it may appear that an effective management strategy may be to treat individual stands as separate management units, the within-stand variability may require different management recommendations and guidelines depending on management objectives. Management activities, including forest ecosystem restoration practices, would need to be tailored for each specific condition.

_____

References:

Corace, R.G., III, H. A. Petrillo, and L.M. Shartell. 2011. Rapid ecological assessment of forests and associated exotic earthworms in the Laurentian Mixed Forest-Great Lakes Coastal Biological Network, Midwest Region, National Wildlife Refuge System, US Fish and Wildlife Service: Summary tables and figures, Shiawassee NWR. Seney National Wildlfie Refuge, Seney, MI. 16pp.

Dufrene, M., and P. Legendre. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. Ecological Monographs 67:345-366.

McCune, B., and J.B. Grace. 2002. Analysis of Ecological Communities. MJM Software Design, Gleneden Beach, OR. 300 pp.